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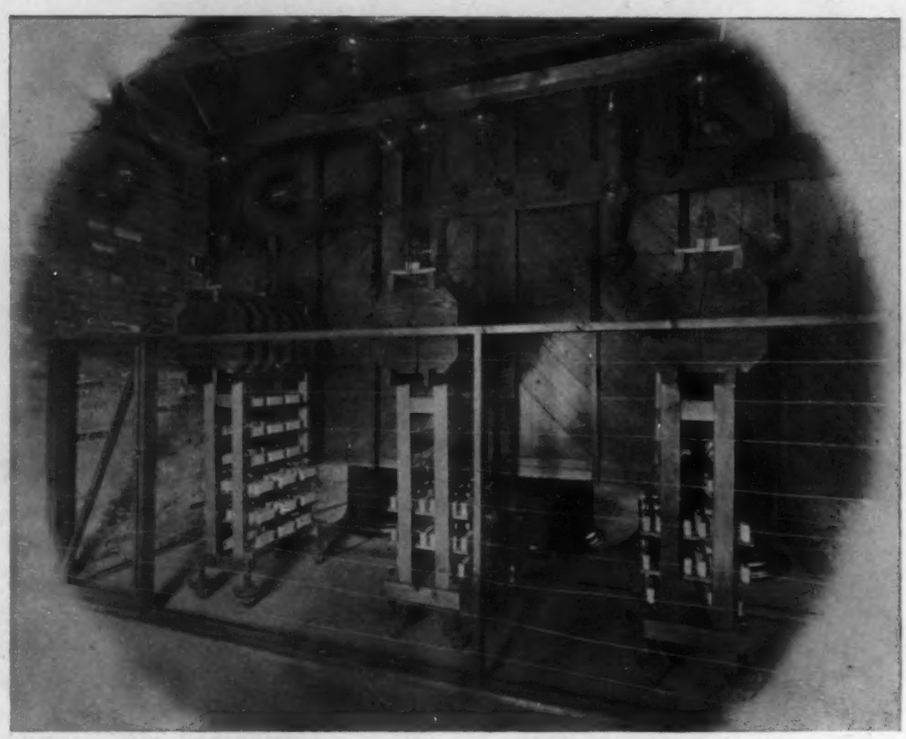
The Provo-Mercur 40,000-Volt Transmission

By LEON W. BLY.

BUT few, even in the electrical transmission fraternity, are aware of the fact that the highest voltage employed in the commercial transmission of power over a long distance is that which is now operated on the lines of the Telluride Power Transmission Company between Provo canyon and Mercur, Utah. The Telluride people are pioneers in the field of extremely high voltage transmissions and for several years have experimented conjointly with the Westinghouse Electric and Manufacturing Company, on transmission lines with potentials ranging as high as 120,000 volts.



FUSES, CHOKE COILS AND LIGHTNING ARRESTERS ON THE PROVO-MERCUR TRANSMISSION.

The line used for carrying out these experiments was a special one extending from the Telluride Company's power house near Ames, Colo., to the Gold King mine and having a length of 11,720 feet. The route of this line was over a rugged country subject to a heavy fall of snow in the winter and rain with severe lightning in the summer. The poles were placed one hundred and eighty feet apart and supported three circuits of No. 8 galvanized iron wire. Practically all the different varieties of cross arms, pins and insulators to be found on the market were tested as were also many new models of these appliances, devised at the time, and during the test runs, the condition of the atmosphere and of the line in regard to snow, rain, humidity, were carefully noted. Up to the present, the results of these impoatant experiments are reserved and every effort to secure the data deduced has been unavailing.

Reverting to the Provo-Mercur transmission, the plans of the Telluride company contemplate the early installation of two thousand horse power, in two units of 750 kilowatts each, to furnish power and lights to the mining interests in and about Mercur and Tintic, Utah. These two districts, which are perhaps twenty miles apart, are respectively thirty-two and forty-six miles from Provo

Canyon, where the power house is located. The Provo-Mercur transmission line is the one which has been placed in operation, but work has been commenced on the construction of the independent line from Provo Canyon to the Tintic district, which will be, as stated, 46 miles in length. After the Provo-Tintic line is completed, the sub-stations at Mercur and Tintic will be connected together by a subsidiary transmission line so that in case of an accident to either main line from Provo, service may be continued without interruption to both places. Immunity from pole line trouble seems to be perfectly secured by this arrangement as the two pole lines take entirely different routes.

At present, one 750 kw. type "A. P." three phase General Electric generator is being operated by a flexible connection to a turbine wheel driven under a head of 125 feet and running at 300 revolutions the turbine being temporarily hand-regulated. This generator has a periodicity of sixty cycles, is star wound, and gives a phase potential of 800 volts. Of the four 250 kw. raising transformers installed in the generating station, but three are in use, the remaining one being as reserve and its connections are so arranged that it can be substituted in service for either of the other transformers at a moment's notice. The normal primary potential applied to the raising transformers is 462 volts, the normal secondary being 23,100 volts. As is the case with the primaries, the secondaries are connected in star, hence the three phase high tension terminals have a phase pressure of 40,000 volts.

The principal material used in the insulation of these high tension transformers is muslin and fullerboard, blocks of maple wood being used to separate the coils. The transformer cores and coils are immersed in mineral seal oil, with no other cooling device than that of the natural radiation of heat from the surfaces of their cases. This radiation is however, very great because of the fact that the surfaces of the cases is rather deeply corrugated. To be exact, the corrugations are 2½ inches deep and one inch wide. The general appearance of the high tension transformers is shown in the illustration appearing on page 171, which also shows plainly the method of supporting the interior high pressure circuits.

The high tension leads are brought out of the tops of the tanks through walnut bushings on the inside of each of which is a heavy porcelain tube extending from the top of the bushing down into the tank beneath the surface of the oil. The low tension leads are brought out at the sides of the tanks and these low tension leads consist of two series of twenty-eight turns in multiple of two three-quarters inch by 349 mils strap copper. The high tension windings consist of 1400 turns of No. 9 magnet wire. These transformers, as well as the lowering transformers at the Mercur sub-station, were built by the Wagner Electric and Manufacturing Company, of St. Louis, Mo., upon the designs and specifications of the Telluride Power Transmission Company.

BREAK SWITCH FOR 40,000 VOLTS ON THE PROVO-MERCUR TRANSMISSION.

Tests made by the writer show the copper loss of the transformers to average about 2150 watts; the iron loss

is about 3030 watts; the normal temperature at full load is 118 degrees above that of the surrounding air.

Three phase generation, three phase transmission and two phase distribution constitutes the scheme of the polyphase equipment, and all the three phase portions are star-connected and the common center or neutral point of the star is grounded as shown in the circuit diagram of connections on page 172. Moreover the two phase distribution is grounded as will be described later. The line is protected by the Wurts non-arcing lightning arresters.

The line, which is carried on 35-foot cedar poles placed 125 feet apart, is of No. 5 B. & S., medium hard drawn copper supported so as to form the points of an equilateral triangle having six-foot sides. One of the three wires is placed on top of the pole and the remaining two are run on the respective insulators of a seven foot cross arm with a separation of six feet between the pins. The

THE 40,000-VOLT TRANSFORMERS.

wires are not transposed, and a metallic telephone circuit is carried on brackets at a distance of 42 inches below the cross arm.

The insulators are of a special type of triple petticoat glass, having two corrugations around the top below the groove designed to carry the line wire. This arrangement not only has the advantage of increasing the surface of the glass between the wire and pin, but it also protects a portion of the surface from extreme moisture during rain storms. The approximate dimensions of the insulator are 6½ inches across the base by 6 inches high, and the insulator is supported by a specially long locust pin made proof against moisture by being boiled in paraffine. Great care was taken to fill the pores of the wood thoroughly, to effect which the pins were kept in the tank in which they had been boiled until they had become thoroughly cooled, after which the surplus wax was removed and the surface of the pin was made smooth by dipping it again in very hot paraffine wax. These pins, being extra long, supported the insulator clear of the cross arm by five inches and the pin used at the top of the pole is two inches longer still, making the separation between the top insulator and the pole to be seven inches.

It appears obvious that an insulator of this design will offer a high resistance to a discharge over its surface, but should it be assumed that it could reach the lower edge of the outside petticoat, there would be little inducement for it to go further as the pin is at all times a good insulator and its surface is of such a nature that a film of moisture will not collect over it. On several occasions insulators have been shattered by marksmen, but it has been the experience that if trouble developed owing to the grounding of the wire on the pin or cross arm, it would promptly rectify itself by the burning off of the cross arm, leaving the wire without support at that pole.

It will be interesting to note that at each pole along the line one can hear crackling from static discharges at all times, and during certain atmospheric conditions, the insulators are dimly luminous with pale phosphorescence. The line itself, however, is non-luminous at all times except for the brush discharges which sometimes exist from points of the line, such as from the tips of the tie wires.

The lightning arresters, as before stated, are of the Wurts type. About twenty-five arresters being kept between the line and the ground. Six choke coils are used, and these are placed edgewise on top of the arrester racks, and as the latter are designed to be as compact as possible, they measure over all but 2 feet, by 3½ feet, by 7 feet high. One of these banks of lightning arresters and choke coils are connected in each line wire as shown in the illustration on page 169.

To be more explicit, the connections of the lightning arresters are arranged as follows: Six choke coils are coupled in series and cut into the line after leaving the transformers. For convenience, we will designate the choke coils by numerals consecutively, coil number 1 being at the left and being connected direct to the line. On the line side of each coil numbered 1 and 2, three Wurts arresters, each containing seven non-arcing cylinders, with about one-twentieth inch gap, are tapped off in series, there being thus two series of three arresters each, for the first two coils. The free ends of the two series of arresters from coils numbered 1 and 2 are closed together, the connection thus formed being termed "point *a*." Similarly the two series of arresters from coils numbered 3 and 4 are connected at point *b*, as are also the two series of arresters of coils 5 and 6 at point *c*. From points *a* and *b* are then carried a single series of five arresters, the ends of these series being joined at the point *d*, while from point *c* is run a single series of eight arresters which are connected to (at point *e*) the terminal of a single series of three arresters between *d* and *e*. Eleven choke coils therefore, intervene between point *e* and either of the six choke coils referred to,

while from point *e* is continued a single series of fourteen arresters running to ground. About twenty-five arresters intervene between any choke coil and ground while a minimum of six arresters are across a coil.

Two further features of interest, also shown in the engraving last referred to, are found in the fuses inserted in the high tension wires, and in the high tension switches used. Each of these three fuses, consists of a single No. 30 B. & S. bare copper wire, thirty-six inches in length, over which an asbestos tube is drawn. The fact that three such thread-like wires will carry a load of over seven hundred horse power, is as incredible to the layman as it is evident to the electrical engineer who fully realize the significance of transmission at a potential of 40,000 volts.

The high tension switches, illustrated on page 170, are inserted on each of the three line wires. They are rigidly connected together so as to be operated by a common switch bar as shown, and each give to a six-foot break, the separation between the switches being five feet.

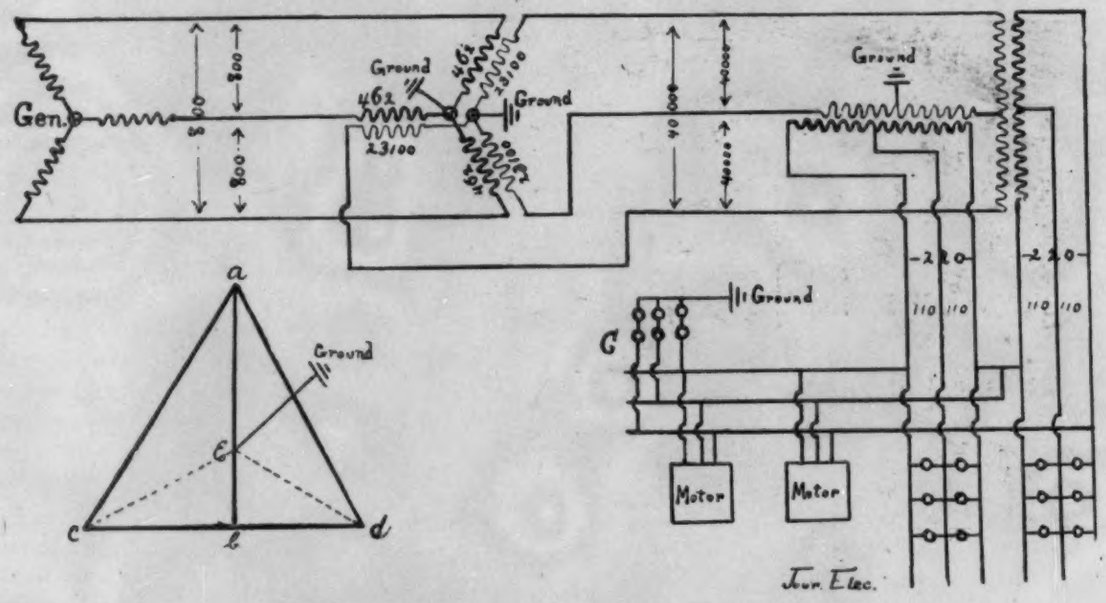
The sub-station now in operation is installed in the Golden Gate mill, at Mercur, which is believed to be one of the largest, if not the largest, cyanide mill in the world. Its electrical equipment, aside from the induction motors used for mining and milling purposes, and as about to be described, consists of three, 300-kw. lowering transformers by means of which the 40,000-volt three phase line current is reduced to 220-volt, two phase current, used for lighting and for operating Westinghouse two phase type "C" induction motors. The plan of connections for the step-down transformers is shown in the sketch on this page, which is a comprehensive outline drawing of the electrical connections of the entire quipment from the generator to the ultimate motors and incandescent lights operated by the system.

These lowering transformers are the same in general design as the raising transfomers in the power house at Provo Canyon, and differ therefrom only in capacity and voltage. It will be noticed too, that, as is the case in the generating station, an extra transformer is installed for emergency use and its connections are so arranged that it can be substituted for either of the other lowering transformers with celerity.

The transforming of three phase current to two phase current and vice versa, by two transformers, is generally understood and will therefore not be taken up.* As previously stated, the neutral point of the three phase system in both the generator and the high tension side of the raising transformers are grounded, and the practice of grounding is carried out even in the low tension distribution circuits in the manner to be shown.

The neutral point of a three phase circuit in a three phase-two phase transformer may be determined graphically by erecting the perpendicular *b a* from the center of the side *c d* of the equilateral triangle shown in the corner of the above plan of circuit connections, and upon this perpendicular *b a*, locate the center of the triangle as shown at the point *e*. Let the line *a b* represent the 100 per cent. side of a three phase-two phase transformer, when the line *c e* will represent the 86 per cent transformers, and the point *e* will be one-third of the length of the line *b a*, measured from *b*. It is at this point that the tap for the ground is brought out, and it is located in the three phase-two phase transformers at one-third of the turns of the 86 per cent. transformer, from the side connected to the center of the 100 per cent. transformer.

The 220-volt secondary is also grounded through incandescent lamps as shown at *C*, where two 110-volt



OUTLINE CIRCUITS OF PROVO-MERCUR TRANSMISSION

*See "Alternate Current Workings" by Donald H. Fry; Journal of Electricity, Vol. V. No. 7, April, 1898.

lamps are connected in series between either of the three wires of the two phase distribution, and the ground. Moreover, a tap is brought out from the center of each of the single phases comprising the two phase system and this tap constitutes the neutral wire of the Edison three wire system which is used at Mercur for incandescent distribution service. Lighting service is taken from both transformers, great care being exercised to keep the entire system balanced, not only as an Edison three wire system, but also to keep each of the two phases balanced with the other. The thoroughness with which the various portions of the high tension three phase system is grounded, as well as the effectual grounding of the 220-volt system, leads to the belief that no danger from shock is presented.

A further feature that will excite surprise is the fact that current is carried from the lowering transformers to the center of distribution in the Golden Gate mill and hoist house by a three-conductor concentric cable, each of the three conductors having a sectional area of 1,000,000 circular mils. The length of this cable leading into the mill is 220 feet and from its terminal is tapped off leads for six induction motors, consisting of one 150 hp. operating rolls, etc.; one 50 hp. motor operating the roasters; one 30 hp. motor operating pumps; two 15 hp. motors operating blowers, and one 10 hp. motor in the machine shop. The length of cable leading into the hoist house is about 60 feet, and from its terminal is tapped off leads for three motors consisting of one 150 hp. and one 75 hp. motors operating hoists and one 100 hp. motor operating an air compressor.

Two other motors, each of 50 hp. operating rock crushers, are run on independent leads from the transformers, and these complete the plant.

TRANSFORMER REGULATION.

By A. R. EVEREST.

REGULATION drop, in a transformer, is the drop in voltage at the secondary terminals of the transformer itself, the primary voltage remaining constant.

Apparently the easiest way to determine the regulation of a transformer would be by direct measurement of the voltage at the secondary terminals; first, when the transformer is carrying no load, and secondly, when the tansformer is carrying full load, the difference between the two being the regulation drop, provided the primary voltage is kept constant. In practice, however, this test is attended with a number of difficulties,—so great, in fact, as to render the test perhaps the most difficult and unsatisfactory of all transformer tests. Even when the voltage on the primary side is observed by an independent voltmeter (and step-down transformer) it may frequently happen that the temperature co-efficients of the two voltmeters are not alike, producing discrepancies in the readings, which, in themselves small, produce a large percentage error in the capacity to be finally determined.

Absolutely steady readings are also desirable for the success of this test, a condition which is very seldom attained. The pulsations of a slow-speed engine reflected on the voltmeter needle are often sufficient to make the test absolutely worthless. There are, as well, several other minor factors which tend to disturb this test, most of which can be met independently, as by exchanging voltmeters between readings, by taking large numbers of readings at each point and averaging results, and so on; but experience continually shows that with the greatest care the results obtained by this method cannot always be relied upon.

Perhaps the hardest point of all in connection with the regulation test, as commonly made, is the difficulty of persuading the station electrician who makes his own

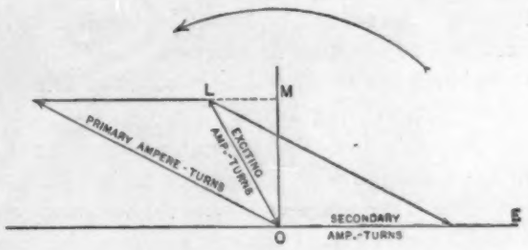


Fig. 1

tests that his results (often absurd) are open to question. But since the losses creating the regulation drop in a transformer can be independently measured, the calculation of the regulation from these observed losses becomes a simple matter.

The "regulation drop" in a transformer is caused by two losses. First, the energy loss, or *C. R.* drop in the transformer windings; secondly, the reactive drop, or "inductance" of the transformer. In certain special cases there must also be taken into consideration the effect of the magnetizing current in the primary, since when the latter is relatively large it produces a phase displacement between the primary and secondary currents and has the same effect on regulation as an increase in the reactive drop.

When this phase displacement is so small as to be insignificant, the calculation of the drop of the transformer is reduced to the resolution of a right-angle triangle.

Draw for the base line the total energy drop, including that in the transformer and in the external circuit. Perpendicular to this, lay off a line representing the reactive drop in the transformer, (in which it is assumed that the external load is non-inductive). The hypothenuse joining these two sides of the triangle now represents the primary applied voltage. We may call this 100 per cent.

If the reactive drop is, say 3 per cent., the horizontal becomes the square root of 100^2 minus 3^2, or roughly 99.2 per cent. If the known *C. R.* drop in the trans-

former amounts to 2.2 per cent we have left 97 per cent voltage (=99.2 per cent—2.2 per cent) at the secondary terminals, as compared with the primary input, or, in other words, there is 3 per cent regulation drop in the transformer. In many cases, however, especially when testing an unknown transformer, it is necessary to take into account the effect of the magnetizing current. The calculation is then not quite so simple, but by means of the method about to be shown, the determination can be made with the greatest accuracy. This method has the advantage of appealing directly to the eye by means of the well known "transformer diagram".

Figure 1 shows the relative directions of secondary current, primary current, the resultant magnetizing force and flux. *O L* is the primary exciting current at no load. It consists of two components, *O M* the true magnetizing component in phase with the flux *O M*; and *M L* at right angles to this, which is the energy component representing the energy expended in core loss.

When the the secondary circuit is closed, the primary current will adjust itself in magnitude and direction so as to maintain the vector *O L* as resultant of primary and secondary magnetizing forces.

The magnetic flux *O M* generates in the tranformer windings a voltage *O E*, 90 degrees behind the flux in phase. This is the active voltage of the secondary circuit, and also appears as the counter electromotive force in the primary circuit, where it is shown as *O I* (Figure 2.)

It is here assumed that the secondary circuit is non-inductive, hence the secondary current is in phase with the induced electromotive force *O E*. (For simplicity it is also assumed that the transformer has a 1:1 ratio). The voltage impressed on the primary to maintain the secondary current must be the resultant of three components (Figure 2.) *I O*, opposing counter electro motive force 90 degrees ahead of flux *O M*. *D I*, overcoming primary C. R. drop in phase with primary current. *R D*, opposing reactive drop, and 90 degrees ahead of primary current. The resultant of these is *O. R.* which is primary impressed voltage.

It will be noted that this primary voltage *O R* is really the resultant of *two* values, *R I* the primary impedance drop, *I O* the secondary induced electromotive-force. If we can calculate these, and know the secondary C. R., we have the regulation at once.

It will be observed that any increase in magnetizing component increases the lag between primary current *O P* and counter *O I*. Since the base line *I D* of primary impedance triangle (the C. R. drop) must always be parallel to *O P*, (the primary current) it follows that an increase in magnetizing component will swing the primary impedance vector *I R* more into phase with the secondary induced volts *I O*, increasing the value of the primary impressed voltage *O R* for any given secondary voltage.

If the diagram is plotted on squared paper with sufficient accuracy, the regulation can be obtained at once from Figure 2, since when *O R* is the primary impressed voltage, *O I* is to the same scale, the secondary induced voltage, and may be expressed in per cent. of the former. Deducting the secondary C. R. drop in per cent, we have the percentage of primary voltage appearing at secondary terminals. But for greater accuracy it is preferable to calculate the side of the diagram.

Let in Figure 3 the vectors *I D* and *D R* be replaced by *I J* and *J R*, the vector of primary impedance *I R* remaining unchanged.

From the known values of primary impedance, C R and reactance, the angle *a* of the impedance triangle is known. The corresponding angle *J I R=b* of the new triangle is equal to *a* reduced by the small angle *J I D*. But this latter angle is the angle of lag between the primary current and the counter and is readily found from the known values of exciting and full load current. A tabulation of the lag angle for values of exciting current from 5 per cent to 20 per cent is given further on.

Having found the new angle *b* and knowing the value of primary impedance, the new vector *J R* (which we may call equivalent reactive drop) is found as the sine of the angle *b* and the vector *I J* (or equivalent primary C R) which is the cosine of the same angle.

Having expressed all the values in per cent of primary

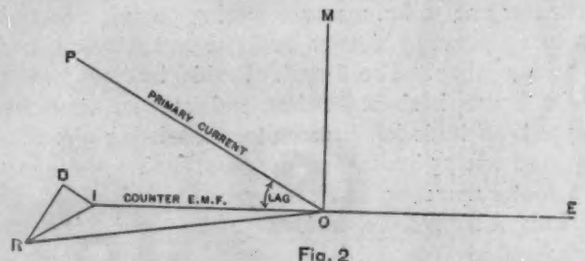


Fig. 2

voltage for convenience, we now resolve the right angle triangle *O R J* taking *O R*=100 per cent *R J*=the equivalent reactive drop in per cent—and obtain *O J* which is secondary terminal volts in per cent, plus the secondary C R per cent plus the primary equivalent C R per cent. Knowing the last two values, we have the per cent. of primary voltage appearing at secondary terminals, and therefore the *regulation* of the transformer.

As an illustration, the method will be applied to the determination of regulation drop at full load of a transformer on which the following measurements are known.

The measurements of copper loss and impedance drop are made by means of a wattmeter, the secondary of the transformer being short circuited as described in Dr. Bedell's paper on transformer regulation published in "The Electrical World."

Capacity of transformers, 2500 watts.
Ratio of transformation, 10:1.
Primary voltage, 1000; frequency, 125 cycles.
Copper loss, ($C^2 R$), 50 watts.
C. R. drop, 2 per cent.
Impedance drop, 54 volts = 5.4 per cent.
Iron loss, 60 watts.
Exciting current, (no load current in primary at 1000 volts), .125 amp.

TABLE OF PRIMARY CURRENT LAG.

Per cent. Exciting Current	Angle of Lag
5 per cent.	2.0 deg.
8 "	3.5 "
10 "	4.5 "
12 "	5.0 "
14 "	6.0 "
16 "	6.5 "
18 "	7.5 "
20 "	8.0 "

This table is not correct for frequencies below 50 cycles.

The lag angle of primary current behind the counter line is determined from the relative values of primary exciting current, the primary full lead current. For convenience, the lag angles are tabulated below for values of exciting current from 5 per cent to 20 per cent on the assumption that the magnetizing component is 80 per cent of the exciting current. (This is sufficiently accurate for all ordinary transformers on frequencies of 50 cycles and above. The value increases, tending towards 100 per cent with the large exciting currents accompanying very low frequencies).

In the case under consideration, we have exciting current 5 per cent, lag angle, 2 degrees.

The total independance drop is 5.4 per cent., the C R drop 2 per cent., and reactive drop $\sqrt{5.4^2-2^2}=5$ per cent.

The *primary* impedance drop is resultant of reactive drop and primary C. R. drop, which we may take as one-half of total C. R. drop. It is therefore $\sqrt{5^2+1^2}=5.1$ per cent.

In figure 2, we then have $I\,R=5.1$ per cent.
$I\,D=1$ per cent.
$D\,R=5$ per cent.

To find the angle $R\,I\,D$ we find what angle has its sine $(R\ D)=\frac{5}{5.1}=.981$. The angle is 79 degrees (See angle *a* figure 3). Deducting from this the current lag angle we have for the angle *b* 77 degrees. $J\,R$ is the sine of this new angle and is $.974\times 5.1=4.96$ per cent. Similarly $J\,I$ is the cosine of 77 degrees and is in value $.225\times 5.1=1.15$ per cent.

To determine the regulation we now resolve the right triangle $R\,O\,J$.

$R\,O=100$ per cent.
$R\,J=4.96$ per cent.
$J\,O=\sqrt{100^2-496^2}=99.87$ per cent.

Deducting $J\,I$—1.15 per cent, we have 98.22 per cent as secondary induced voltage $(I\,O)$ and deducting again secondary C. R. drop 1 per cent we have 97.72 per cent of primary applied voltage appearing at the secondary terminals or a regulation drop of 2.28 per cent.

It is of interest to note here that figuring the regulation of this transformer by the simpler method first described, entirely ignoring the effect of exciting current, the result gives 2.13 per cent regulation drop, a difference of 0.15 per cent due to 5 per cent exciting current. With a larger reactive drop in the transformer, other losses being equal, the difference between results obtained by the two methods would be somewhat geater.

Calculated by Dr. Bedell's method before referred to, the regulation drop obtained is 2.44 per cent,—slightly higher than that by the method above. This is due to the fact that Dr. Bedell's method assumes that the magnetizing current is equal to the exciting current which is not the case, and also in a slight degree to some other

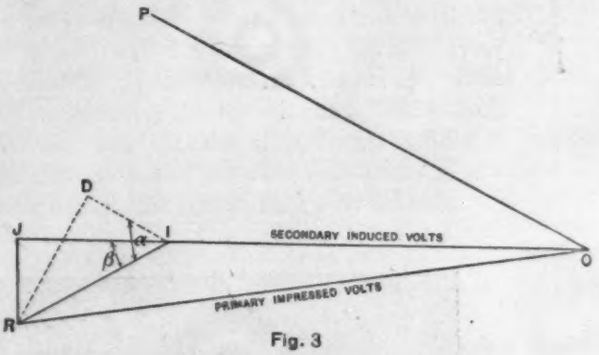


Fig. 3

minor approximations adopted in the construction of his diagram.

The percentage of iron loss and exciting current taken in the above illustration are higher than would be found in good modern transformers of any but the smallest sizes but they have been purposely taken here to illustrate the point under discussion. For the same reason the diagrams are greatly exaggerated. In actual practice the primary current line $O\,P$ is very nearly parallel with the line $O\,I$.

Fraternal

THE ANNUAL MEETING OF THE TRANSMISSION ASSOCIATION.

The annual meeting of the Pacific Coast Electric Transmission Association will be held at San Francisco on Tuesday, the 21st day of June, 1898. The session will be opened at the Cliff House at 2 o'clock in the afternoon.

After the enrollment of new members, papers will be read by E. S. Cobb, M. E., on "Electrically Driven Centrifugal Pumps;" R. S. Masson, Electrical Engineer of the Pacific Coast District of Westinghouse Electric Mfg. Co., on "Electric Motors for Pumps;" F. F. Barbour, Manager, Power and Mining Department of General Electric Company, Pacific Coast District, on "Distribution in small units from High Potential Circuits," and Leon W. Bly of Telluride, Colo., on "Some Experience in Extreme High Potential Work."

There will also be presented papers by John Martin, Pacific Coast Agent, Stanley Electric Manufacturing Company, and R. M. Jones, manager of the Big Cottonwood Power Company of Salt Lake City.

A supper, to be provided by the Association, will be served at 6 p. m., after which the evening will be devoted to the reading and discussion of papers.

The coming meeting promises to be a very interesting and instructive one, and it is hoped that all of the members of the Association will be represented so as to avail themselves of the opportunity afforded to gain practical information from those who have had experience with electric transmissions under working conditions, and to form acquaintances which will prove pleasant and profitable. As stated, the supper will be provided by the Association, and each member entitled to two representatives.

Mining

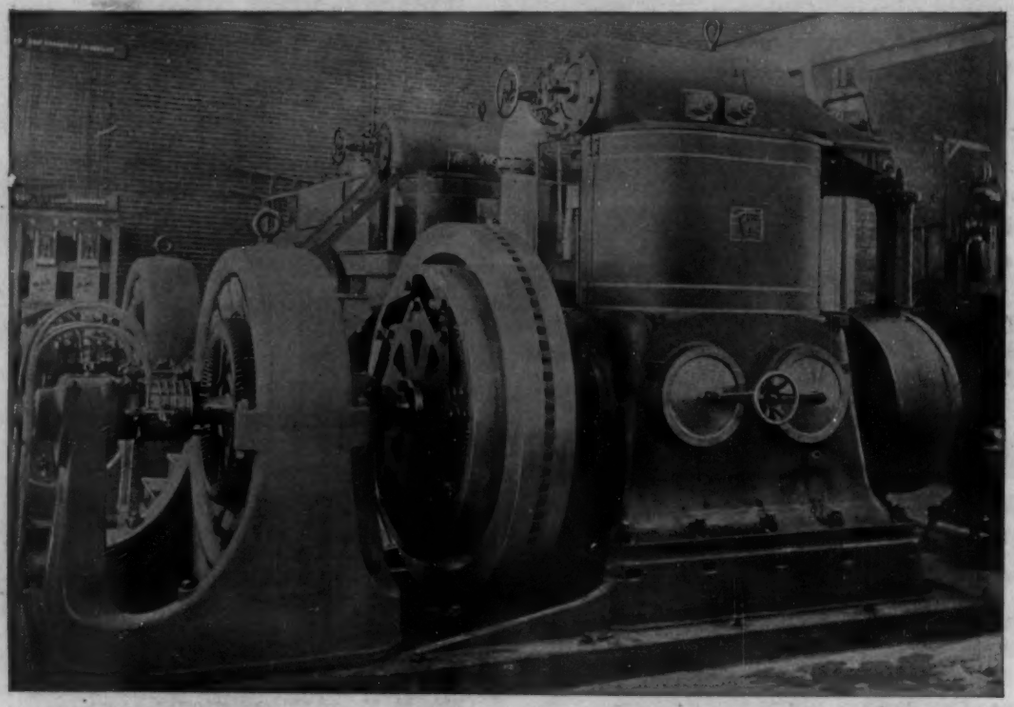
ELECTRICITY IN MINING.—II.

THE application of electricity to the art of mining has been developed largely within the past five years. In 1893, Prof. John P. Barrett, in his book, "Electricity at the World's Columbian Exposition," made the following statement: "As applied to mining, electricity is comparatively new, and its advent is in consonance with the commercial success of the alternating current for lighting and power work. Heretofore the difficulties have related to cost alone."

"The commercial success of the alternating current" has been largely due to the fact that the experts of one of the largest of electrical manufacturing companies developed that form of electrical power in the face of considerable opposition, both from men of science and from legislative assemblies. The manufacturers are reaping their reward, however, in the present state of electrical construction.

Thanks to the efforts of such enthusiasts, the question of cost has ceased to discount the use of electric apparatus. Where a source of water power is available, even though at a considerable distance, the modern methods of long distance transmission at high potential make the operative expense of an electrically equipped mine ridiculously small when compared with the figure for any other form of power. Even where the mine is operated by electrical machinery which is itself driven by steam power, the convenience and safety of electric transmission make it by far the most economical method—with present efficiencies—of all that have been proposed.

The long distance system depends for its success upon the well known property of alternating current which makes it possible to transform it, by means of suitable apparatus, from a small current at a very high voltage to a larger current at any desired lower voltage, the amounts of current in the two cases being inversely as the voltages at which they are carried. As the waste of energy in transmission varies with the square of the current, it will be seen that the loss in transmission over a long distance line will be very small because of the small amount of current carried. At Niagara Falls, where the power of the cataract is developed by 40,000 horse power of Westinghouse generators, the current is distributed in this way over a radius of 30 miles, and is sold at Buffalo, the extreme point of distribution, for sixty-four hundredths of one cent per kilowatt. This is equivalent to less than one-half of one cent per horse power per hour. It is safe to assert that nothing approaching this efficiency has ever been attained in mining practice with any other kind of power.



A CORNER IN THE WESTINGHOUSE STATION.

The advertising efforts of the larger of the electric companies have been for the past few years directed toward extending the range of application of their pro-

ducts. In the arts of papermaking,* printing, tanning, in packing houses,** lumber mills, textile plants, and in mining, the advantages of electric power have been more or less thoroughly exploited. It is the object of this article to inquire into these advantages and to ascertain the degree to which the results obtained in practice will bear out the claims of the advocates of electric power in mining.

Cheapness is not the only requisite of success. A tallow candle on a miner's hat is cheaper than a safety lamp, at least in first cost; subsequent events may disprove the contention.

Power as used in mining, may be classed under the following heads, which will be considered separately:

1. Motive power, tramways, hoists, etc.
2. Lighting.
3. Auxiliary power, ventilating fans, pumps, etc.
4. Operative power, drills, picks, stamps, crushers, compressors, and other machinery.

Steam, water, and compressed air are the principal other forms of power employed. The items of expense in a steam plant are as follows: boiler, engines, (condensers, etc.), piping to points of distribution, with costly valves and auxiliary apparatus. The expense of operation comprises coal, water, oil, and expert attendance. Where compressed air is used, there must be added compressors storage tanks, and additional piping and operating expense. The hydraulic system is available in certain cases for special purposes involving the expense of a dam or of a reservoir and pump, unless nature has provided their equivalent. Complicated systems of piping and machinery are required. Aside from the item of cost, there are objections to all of these systems, because of various defects of adaptability, safety and the like.

Electric power is clean, safe, convenient, and in mining districts, as explained above, usually cheap. It produces no refuse, no troublesome side products; it is easily transmitted, and occupies modestly only a very small amount of space in its travels through the recesses of the mine. The advantages here enumerated may be studied from a practical standpoint in the many large mining installations throughout the country, designed and installed by the principal electric companies.

1 Electric Hoists and Tramways.

The requisites of a successful mine hoist vary according to the special kind of service. For some purposes, the mechanism must be well protected from dust; for others, it should be thoroughly ventilated; in almost every service, the elevator must be capable of reversal without changing or adjusting the prime mover. The latter should require little attention, and should not be liable to derangement. Constant speed is often desirable; constant torque is sometimes required.

These essentials are met satisfactorily by the modern type of dust proof motor. This machine, developed by the Westinghouse company, is an offshoot of the standard type of multipolar motor, which has become famous. It is designed to hang in almost any position, is securely encased in a cylindrical frame, and is absolutely spark proof and dust proof. As an example of the freedom of these motors from sparking, it may be mentioned that one of them was supplied by the Westinghouse company for the ammunition hoist of the United States battle ship "Indiana," and was naturally subjected to very severe service, in which, however, it has given entire satisfaction. The brushes require no attention, and the direction of rotation is reversed without the least regard for the ordinary motor sensibilities. As applied to mining hoists, this type of machine has attained unquestioned success. It is made in sizes of from 10 to 200 horse power.

Where the presence of explosive gases makes the use of direct current unadvisable, a polyphase system, preferably of low frequency may be introduced. Polyphase machines are made of the inductor type, i. e., without brushes or sliding contacts. Polyphase transmission may be direct, that is, generated near the points of distribution at the voltage desired or indirect, in which case transformers are used as previously descibed. A noteworthy example of the former case is at the immense factory of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penn. A view of one corner of the power house is shown in page 176. All the machinery in this great establishment, comprising upward of 1300 machine tools, is driven by electricity supplied to Tesla polyphase motors, the current being two-phase, with a frequency of 25 cycles per second. The potential used is 200 volts, and this being approximately the generator voltage, is supplied without the interposition of transformers.

In using the polyphase system it should be noted that if the frequency selected be suitable, the mines can be lighted from the same circuits that are used to supply power. A frequency of 25 cycles per second permits incandescent lighting that is entirely satisfactory for mine work, but it is too low for arc lighting. A line of polyphase motors is built by the electrical companies for a frequency of 60, and this is adapted to both incandescent and arc lighting. The lower frequency possesses the advantage of reducing the speed of the motors.*

The electric locomotive has passed the experimental stage and is an assured success, as has been demonstrated in scores of instances. For mining work, it may be said that the electric locomotive is the only locomotive. No smoke, no dust, no moving cable, no danger or inconvenience of any kind accompanies its use. It is compact in form and noiseless in operation. For hauling in mines electricity is fast superceding steam and mule

*See paper by Mr. Chas. F. Scott, on "Electricity in Paper Making," read before the American Paper and Pulp Association, February 16, 1898.

**See "Electricity in Packing Houses," "The Western Electrician," May 28, 1898.

*Some technical consideration governing the design of mining motors are set forth in an article by Prof. F. C. Caldwell in "Mines and Minerals" of May, 1898, entitled "The Design of Mining Motors."

power. In well ventilated mines there is no danger from the ignition of the gas by sparks from the electric machinery, and the electric locomotive does not vitiate the air. The small amount of apparatus necessary for the installation of the electric plant is in its favor, as a small copper wire takes the place of the large amount of piping and the air storage tanks for pneumatic locomotives. The weight of an electric locomotive is less than of a compressed air or a steam locomotive adapted to the same work, as the apparatus for generating or storing the power in a central station instead of on the machine, as is the case with steam and pneumatic locomotives. The capacity for hauling on grades is greater, as the full power of the central station is available, up to the full capacity of the motors, which are thus enabled to perform temporarily an abnormal amount of work when suddenly called upon for such service.

The capacity of electric locomotives ranges from 50 to 200 horse power, and the draw bar pull from 3000 to 10,000 pounds or more, according to the weight. The draw bar pull may be increased by adding cast iron to get adhesion to the rails. The locomotives are constructed in the same substantial manner as steam locomotives. The gears are of cast steel or malleable iron, machine cut, and run in oil tight cases.

*The smaller sizes may be adapted for wooden rails, but where the wooden rails have not an iron edge, the wheels are made with a special tread and flange, and therefore a description of the rail on which a locomotive is to run should always accompany an inquiry.

The Westinghouse-Baldwin locomotive frame consists of heavy cast iron side and end pieces securely bolted together and kept square by machined joints and shoulders accurately fitted. These frame pieces are planed top and bottom and on the ends, to insure perfect accuracy in fitting up, and inter-changability of parts. The pedestal caps are forgings made to template and accurately fitted so as to relieve the frame from breaking strains in case of severe shocks. The frame is placed outside the wheels, thus allowing all possible space between wheel hubs to admit the greatest practicable width of motor. This feature is of much importance in obtaining the maximum power on narrow guages. Furthermore, this construction permits of ready accessibility to the journal boxes and protects all moving parts in case of derailment. Heavy planking with hinged doors is laid on top of frames, thoroughly protecting all electrical parts while permitting access to the same for inspection. End bumpers and coupling hooks are provided in conformity with the purchaser's requirements. The operating platform is placed at one end and is compactly and conveniently arranged so that the motorman has all levers within reach without leaving his seat.

The locomotive is driven by two spring supported motors, one geared to each axle by single reduction gearing running in oil lubrication in tight cases. These motors are designed especially for mining service and are of the four pole, steel clad, enclosed railway type. The armature is iron clad, the coils being held in slots below the surface and secured by wooden wedges, as in the most approved railway practice.

The current controller is of the latest rheostatic type, with magnetic blow out to prevent arcing at the contacts. It is provided with six speed changes and is operated with handles for starting and reversing.

The trolley pole is especially designed for this service. It is reversible and can be placed in a socket on either side of the frame. It automatically adjusts itself to varying heights of trolley wire, and is thoroughly insulated to prevent shocks to the operator when being handled. The current connections are made by insulated cable.

The locomotive is provided with all necessary minor electrical fittings, such as fuses, lightning arrester, main switch, and two electric headlights.

All sizes of this locomotive are designed to run at a standard speed of eight miles per hour while developing their full tractive effort. With light trains requiring less than full power, the speed of the locomotive may be increased. When starting, the train is brought up to speed gradually by means of the controller.

The accompanying table gives the standard sizes of of Westinghouse-Baldwin mining locomotives with their performance, weight, and minimum dimensions. The draw bar pull has been figured at full load and standard speed for the locomotives hauling trains on a straight level track, and also on the limiting grades, found in ordinary mining practice; the assumed adhesion of the locomotive being that with a fairly good condition of the track and rail.

Curves offer considerable additional resistance to the movement of the locomotive and cars, and must be taken into account if of short radius, especially when they occur on grades. With the track in fair condition the curve resistance may be taken at one pound per ton weight of trains per degree of curvature.

The number of tons weight which a locomotive will haul at standard speed on straight track may be calculated from the table, when the grade and frictional resistance of the cars is known. The frictional resistance will vary greatly with the kind of cars, the conditions of journal lubrication and the condition of the track.

For the average mining locomotive, the friction may be taken at thirty pounds per net ton weight of the loaded cars, but it may frequently amount to forty pounds per ton or more, where conditions are unfavorable. To find, therefore, the number of tons (2000 lbs.) of train which can be hauled by a given locomotive; take from the table the number of pounds of draw bar pull that will be exerted by the locomotive on the limiting grade in the mine, and divide that figure by the train resistance in pounds per ton on the grade; the quotient will be the weight of train hauled. The train resistance per ton is found by multiplying the per cent. of

*See pamphlet on "Electric Locomotives," by David Leonard Barnes.

grade by 20 lbs. and adding 40 lbs. friction to the result.

All these locomotives have parallel rods, which prevent loss of power and time, due to slipping of individual axles. This is an important feature where there is fine coal dust or moisture. Each locomotive is provided with two sand boxes, front and back, both of which can be operated from either end. These sand boxes can be provided with electric heaters, if desired, to keep the sand dry. The protection for the head of the motorman is hinged to swing so that he can stand erect in parts of the mines where the head room is sufficient. Suitable brakes are provided, which can be operated from either end, and are powerful enough to utilize the entire adhesion for braking force. The gears are of the best wearing material, accurately cut. The wheels may have chilled treads or steel tires shrunk on, while the crank pins and parallel rods are of open hearth steel, the rods having bronze bushings. One of the largest of this class of mining locomotives which has been in constant daily use for months, has a capacity of 200 horse power at six miles per hour with a track guage of three feet six inches. These requirements make it necessary to raise the motors above the wheels, and to use intermediate gearing. The Westinghouse Company furnishes photographs of the uncovered machine, showing how this is accomplished. This 200 horse power mining locomotive is covered at the points requiring protection from the rain, hence all parts are accessible and can be watched by the engineer while in motion.

Class	Total H.P.	Speed M. P. H.	Full Load Draw Bar Pull in Pounds					Minimum Track Gauge	Wheel Base	Diam. of Wheel	Width	Length	Height.	Wght. Lbs
			Level	1 per cent grade	2 per cent grade	3 per cent grade	4 per cent grade							
$4\frac{2}{c}$	20	8	900	840	780	720	660	24 in.	44 in.	24 in.	41 in.	10 ft. 4 in.	33 in.	7000
$4\frac{2}{10}c$	20	8	900	840	780	720	660	30 in.	44 in.	28 in.	47½ in.	10 ft. 4 in.	33 in.	7000
$4\frac{2}{15}c$	30	8	1250	1170	1090	1010	930	30 in.	44 in.	28 in.	47½ in.	10 ft. 4 in.	33 in.	8500
$4\frac{2}{25}c$	50	8	2100	1980	1860	1740	1620	30 in.	44 in.	30 in.	48 in.	10 ft. 4 in.	33 in.	12000
$4\frac{2}{35}c$	70	8	2900	2730	2560	2390	2120	30 in.	48 in.	30 in.	53 in.	11 ft. 6 in.	34 in.	17000
$4\frac{2}{50}c$	100	8	4300	4060	3820	3580	3310	36 in.	48 in.	30 in.	53 in.	12 ft. 0 in.	36 in.	24000
$4\frac{2}{75}c$	150	8	6500	6160	5820	5480	5140	56½ in.	60 in.	36 in.	74 in.	13 ft. 6 in.	42 in.	34000

PERFORMANCE AND LIMITING DIMENSIONS OF MINING LOCOMOTIVES.

The size of locomotive required for any given case may be calculated, but is preferably determined by making a number of tests with a dynamometer to ascertain the draw bar pull. It is of the greatest importance to have sufficient weight on the drivers.

Tests made by Messrs. Buck and Belsey, students at Sibley College, Cornell University, gave the following instructive results:—

The ratio of the dynamometric horse power to the electrical horse power at the motor terminals was from 42 per cent. to 65 per cent. at a speed of from four to six miles per hour, the maximum draw bar pull recorded being 5,700 lbs. The locomotive was a 10-ton, 80 hp. machine, with a single reduction motor, the axis of the armature lying in the direction of the track; both pairs of wheels were geared to it by bevel gears. A shop test of this locomotive, under which 86.7 ehp. was delivered to the machine and a speed of 8.56 miles per hour obtained, gave as the total losses 21 hp., or 24 per cent., of which the gear loss was 5.5 hp. or 6.4 per cent. The rolling friction was 5.7 hp., or 6.6 per cent, and the electrical loss 9.7 hp., or 11.2 per cent. The measured draw bar pull was 2,700 lbs. The Baldwin-Westinghouse electric lomocotive, previously described, greatly surpasses in efficiency any such results as the above.

The rapid development of the electric locomotive is explained by the fact that the greatest companies in their respective fields of electricity and locomotive construction, the Westinghouse Electric and Manufacturing Company and the Baldwin Locomotive Works—joined forces in this direction and worked out jointly the details of these machines. The Westinghouse-Baldwin is the product of that union, and is a successful locomotive of to-day. Mr. R. G. Vance, Superintendent of the Stevens Coal Co., Acme, W. Va., writes, "It (a Westinghouse-Baldwin mining locomotive) works like a charm * * * It will do from 25 to 50 per cent. more work than the specifications call for."

(Continued in Next Number.)

Personal

Dr. F. A. C. Perrine, electrical engineer for the Standard Electrical Company of California, has left for a business trip in the East and will probably be absent for two months.

Mr. Robert McF. Doble has resigned the secretaryship of the Blue Lakes Water Company and will hereafter devote himself to the duties of his position of president and manager of the Abner Doble Company.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

OFFICIAL ORGAN OF THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION.

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EDITORIAL.

THE P. C. E. T. CONVENTION.

With this month comes the second annual meeting of the Pacific Coast Electric Transmission Association, to be held at the Cliff House, San Francisco, beginning Tuesday, June 21st, as announced on another page in this issue. From the list of papers to be presented and from the number of letters that have been received from members expressing an intention to be present, no doubt is felt but that the coming convention will be one of the most successful and profitable gatherings of technical men ever assembled on the Pacific Coast.

The interest which is being taken in the affairs of the Transmission Association is indicative of the growing importance of the industry it represents in the Far West. A chapter in the history of the development of this industry is told in the editorial following this and ere the month closes, the transactions of the Transmission Association will have exceeded the latest and best advances in the electric transmission of energy.

It is well that the Constitution of the Association, as ultimately adopted, pursues a liberal course in regard to membership for, while adhering vigorously to the qualifications for active members, it avails itself of the wisdom and experience of its hosts of allied interests by permitting their enrollment as Associate members. The fruits of this sound policy are being evidenced in the rapid increase in the list of associate members, and it is urged that applications for associate membership be made by all who are interested in, or have dealings of any nature with electric transmission enterprises. No feature of the industry is too small for investigation and scruntiny and thorough specialization is the keynote of highest attainment in operation efficiency.

A milestone marking the progress of the electric transmission industry was turned in the permanent organization of the Pacific Coast Electric Transmission Association by the election of its first board of officers, and as a fitting observance of the event the Journal of Electricity presents, as a frontispiece to the volume now closing, the portraits of its first officers.

Of these, the President of the Association, Mr. C. P. Gilbert, is a graduate of the University of Michigan as an electrical engineer in the class of 1870, whence he served as United States assistant engineer on various government works until 1888. He then took charge of the business of the Edison Illuminating Company, of Detroit, Mich., as secretary and manager, during which time he was elected Vice President of the Association of Edison Illuminating Companies, afterwards serving for several years as chairman of its executive committee. Since July, 1896, Mr. Gilbert has been General Manager of the Sacramento Electric, Gas and Railway Company, of Sacramento, Cal.

Mr. H. H. Sinclair, Vice President of the Association, has been prominently before the electrical fraternity from early in the '90s, when he pioneered three phase systems in the transmission of the Redlands Light and Power Company, up to the present time in his capacity of vice president and general manager of the 80-mile transmission of the Southern California Power Company, now in active construction. Mr. Robert McF. Doble, Secretary and Treasurer, attained prominence on the electric transmission field through the active part he took in the building of the plant of the Blue Lakes Water Company, the engineering features of which were entrusted to Mr. Doble, then secretary of the company. He has recently, however, retired from the Blue Lakes Company to accept the presidency of the Abner Doble Company.

Messrs. W. Frank Pierce and John J. Seymour, as members of the Executive Committee, complete the list of officers of the Association, and of these, Mr. Pierce is president of the Blue Lakes Water Company. Though Mr. Pierce is practically a newcomer in the electrical field, he is, nevertheless, a most valuable acquisition as the engineering world will soon realize from the important part he will take in the installation of the proposed 110-mile transmission of the Standard Electric Company of California, to run from Blue Lakes City to San Francisco. Mr. Pierce is also a director of the Yuba Power Company operating the Yuba-Marysville transmission.

Mr. Seymour is a native of Ohio, and is a graduate of the class of 1877 in Civil engineering of the Illinois State University. For thirteen years thereafter he followed the profession of civil engineering, together with the kindred one of mining engineering, in Colorado and California, but in 1890 he became associated with the Fresno (Cal.)

Water Company, since which time he has been its president and manager. In 1895, he took up the financial end of the scheme suggested by Mr. John S. Eastwood for the electric transmission of power into Fresno from the headwaters of the San Joaquin River, and the success of his efforts is attested in the installation of the San Joaquin Electric Company that at once sprung into fame for being the then longest distance transmission, and for operating under the highest head—1140 feet—of any transmission in the world. Mr. Seymour's electrical knowledge and experience has been acquired since the inception and formation of the San Joaquin Electric Company, of which he is the President.

GIVE HONOR TO WHOM.

In each branch of science, as in every epoch of history, is recorded a name which, for some special attribute or boldness of action, stands as a mile stone along the pathway of time. Within the realms of electrical theory will be given to posterity, as they are revered to-day, the oft repeated names of Faraday, Maxwell and Henry among the dead, and of hosts of those among the living; within the realms of electrical practice who, aside from the master minds in the service of the great manufacturing companies, will stand prominent in the estimation of future generations for the substantial achievements of their abiding faith and for doing that which was necessary to finally place the science of electricity on the high plane of commercial utility where it will ever stand in the world's affairs?

Each branch of the science, whether in theory or in practice, or whether in telegraphy, telephony, illumination, transportation or transmission, or whether in other perhaps less important ramifications of electrical application, will furnish history with a master mind outshining, in matters of priority at least, all others. Every honor is cordially bestowed upon the designing engineers whose fertile brains have made possible the subjugation of nature's potent forces for the electrical transmission of power by high tension currents. Let us bestow, then, equal honor upon those far-sighted business men who early appreciated the utility of advances in electrical engineering and whose gold paid for the crucial tests without which electrical transmissions would yet be but interesting laboratory experiments.

The great west has furnished more than its quota of names that the future should revere as illustrious for their achievements in demonstrating the vital requisite of the commercial feasibility of electrical transmision of energy Fifteen, and even ten years ago the proposed long distance electric transmission of electricity for power or even for incandescent lighting purposes, was looked upon as perhaps remotely possible, or at best, as no nearer realization than is aeronautics to-day, and the non-technical man who ventured his money or that of his associates in such a project, did so under the inspiration of an abiding faith and generally amid direful forebodings. They are the true pioneers of electrical transmissions, and to them all honor is due.

The first electric transmission on the Pacific Coast was brought about through the untiring efforts of Mr. P. F. Morey, father of the Willamette Falls Electric Company, afterwards succeeded by the Portland General Electric Company, and who, early in 1888, installed a 4,000-volt transmission from Oregon City to Portland, 13 miles, the plant having a capacity of about 1250 horse power and being used for incandescent lighting purposes alone. Necessity for the delivery of power from the transmission circuits had become of paramount importance some six years later when Mr. J. B. Leggett, of the Standard Consolidated Gold Mining Company, of Bodie, Cal., after most disheartening delays and failures, succeeded in operating the mine and mill of that important property by single phase motors, the transmission being of 400 horse power, a distance of 12½ miles.

The possibility of reaping the advantages that would accrue from using higher voltages gave rise to the next important development, and early in 1893 the San Antonio Light and Power Company, under the presidency of Prof. C. G. Baldwin and the managership of Mr. A. W. Burt, placed its thirty mile line to San Bernardino and its fourteen mile line to Pomona, Cal., in operation for lighting purposes, utilizing 10,000-volts. This plant was, at that time, the cynosure of electrical engineers the world over, and it is interesting to note as exemplifying the rapid advance that has been made in transmission work in five brief years, that the step-up transformers of the San Antonio plant, which are still in operation as originally installed, consists of twenty transformers taking single phase current at 1000 volts from the generator in parallel, and delivering energy at 500 volts, the twenty 500-volt secondaries being connected in series, giving 10,000 volts to line.

The Bodie experience, though not unsatisfactory at the time, demonstrated the difficulties attending the transmission of power by single phase currents, but nevertheless Mr. Leggett proved, in a thoroughly practical way and under difficult conditions, that electric power could be relied upon—an idea which had, prior to that time, been gravely questioned. Single phase motors are, as all know, possessed of inherent drawbacks which made the announcement of the invention of polyphase motors more than welcome, and to Mr. H. H. Sinclair, of the Redlands (Cal.) Light and Power Company, is due the credit of installing in June, 1893, the first three phase plant for the transmision of power. Two years later Messrs. H. P. Livermore and Albert Gallatin had placed the Folsom-Sacramento transmission in operation and were delivering 4,000 horse power over a three phase, twenty-two mile transmission. After that, electric power transmissions found the way clear from a financial standpoint, as is attested from the great number of plants installed since, and those which were subsequent, merely

followed along the well trodden paths beaten out by the pioneers of the art.

There still remained however, room for pioneering in the unexplored domain of higher voltages, for with the exception of the Newcastle-Sacramento transmission, installed by Dr. Charles Van Norden and operated at 16,000 volts, the potentials used have hovered about that iniatiated by the San Antonio transmission, namely, 10,000 volts. Mr. Sinclair was first to make public proof of his convictions in the practicability of operating transmissions at potentials above 30,000 volts, in the organization of the Southern California Power Company, which will be operating a 4000 horse power, 33,000-volt transmission over an eighty mile line into Los Angeles by September next, but while these developments have been transpiring, Mr. L. L. Nunn, of the Telluride Power Transmission Company has been quietly prosecuting practical experiments under most adverse climatic conditions with the view of determining the maximum potentials that may be made available for transmission purposes. He has constructed an experimental line, two miles in length, on a mountainous region subject to lightning, snow and sleet, and he has tried almost every conceivable form of insulator material and insulator, as well as potentials ranging up to 120,000 volts. With the extremely high potential named, it was not possible to hold it on the line in that locality, although it is believed that it may be held under more favorable climatic conditions—in fact, the trend of the experements is that no law as to permissible potentials can be given, as they will vary in each and every case with the conditions under which the transmission is to operate.

A convincing evidence of the conclusions reached is found in the interesting description of the Provo-Mercur transmission, from the pen of Mr. Leon W. Bly, first published as the leading article in this issue. From it will be seen Mr. Nunn's deductions that in Utah it is entirely practicable to use 40,000 volts for transmission purposes, despite the fact that some portion of the line traverses a mountain at an elevation of upwards of 9,000 feet above sea level. The Provo-Mercur transmission has been in satisfactory operation for four months or more.

Surely, then, Mr. Nunn is, of all others, the most noteworthy pioneer in the practical installation and operation of extremely high voltage transmission lines and his achievements in this direction have won for him well-deserved and enduring fame.

THE SALESMAN OF THE FUTURE.

The day is fast approaching, if it is not already here, when the salesman for the electrical manufacturing and supply house can no longer score triumphal success in working along the old lines of being "a boy among the b(hic!)oys."

Like all other branches of industry that at the outset depended upon vigorous exploitation, the pioneering times of electrical work had its period of individualism when the "personal equation," rather than the intrinsic worth of the apparatus, proved the turning point in the closing of a contract. Prices were realized which, in view of present values, now seem fabulous; and the importance of technical details were, in those early days, set at naught in blind but sublime faith in the ability of the installing engineer to faithfully execute each and every condition of a contract, however absurd or unheard of. With the engineer of that day nothing must be impossible of technical accomplishment; with the salesman, always of glib tongue and Bohemian penchant, it was more often the rule than the exception that his prime qualification consisted in an enormous capacity for hustling, story telling and riotous demeanor. In truth, the "old timers" will attest the fact many of the earliest electrical projects, now grown to giant corporations, were built in the shipyards of the banquet table and launched on the flood of its wines.

Now all is changed and the present time marks the era when the buyer is, or is fast becoming, as conversant with electrical engineering practices as is the seller. More than that, the seller generally knows his own apparatus thoroughly, while the intelligent buyer, and the buyer of any particular quantity of electrical apparatus is always intelligent, acquaints himself with the electrical and commercial features of each make of the variety of apparatus he is to buy before closing the contract. The time for "wool pullings" have passed and electrical machinery must now be sold by salesmen who are skilled engineers in both a practical and a technical sense.

Here is indeed an avenue of occupation for the hosts of highly trained electrical engineers that the educational institutions of the country are turning out each year.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

"The Treatment of Disease by Electric Currents;" by S. H. Monell, M. D. Published by William Beverley Harrison; 8 vo., 1088 pages, 12 pages index. For sale by the "Emporium," price $6.

Like the previous volume by the same author, the book under present consideration presents some features of value, and some that cannot but be condemned. It is largely a compilation, and as such alone is to be commended, but unfortunately the author has seen fit to leave out the work of certain men, along various lines, that has been both scientific and of value; this is notably the case in the section on diseases of the eye, in which department there is no mention of the excellent work of Alleman, of Brooklyn, N. Y., on the treatment of leucoma. On the other hand the writer has collected and placed in one volume, the recorded facts in connection with the electrical treatment of a very large number of

diseases, and has thus rendered no small service to those who are not sceptical of the value of electricity in treating conditions other than those found in the female pelvis. Dr. Monell has a certain amount of ability, but it is unfortunate that his writings are not rigorously edited by some one conversant with the terminology and fundamental principles of electricity. He is led, through lack of exact knowledge, into many errors which may not render the book less valuable to the practitioner, but which do certainly mar it as a sample of the teaching of medical men, on the subject of electricity.

As a text for the clinical instruction of the practicing physician, the book is of great value, for the directions are clear and explicit, and are given in a dictatorial tone that carries conviction to the mind of the average physician. Perhaps this is carried to too great an extreme and more claimed than one who has used electricity for any length of time will be willing to grant; but, on the other hand, many men have used electrical treatments for years and have failed to secure certain effects because they do not know anything of the fundamental principles of the agent they are using, nor are they conversant with the best methods of applying the remedy they would use. Many matters in the domain of electro-therapeutics are still open questions, and are bound to so remain until medical students are turned out with a knowledge of electricity that will enable them to intelligently undertake the treatment by electricity, of these conditions that are in the uncertain land.

The book has fallen into the customary sin of its predecessors on electro-therapeutics, and is loaded with cuts taken from manufacturers' catalogues. We fail to see why it is that all these books should have their pages marred by such cuts; yet the fact remains that no work on the subject, with which we are conversant, is free from this clumsy error in taste. The present work is quite the greatest sinner in this respect that has yet been published. Not satisfied with publishing these cuts once, many of them are repeated over and over again, sometimes the same cut being printed three times on two consecutive pages. One cut is repeated 105 timees and, by actual measure, takes up no less than 32 pages of the volume! Another is repeated 36 times, at a cost of over seven pages of space. And these are not cuts of any value, but are quite the contrary; the first referred to is an attempt to picture a simple pad, or indifferent electrode, and the second is a bi-polar electrode for the vagina. The frequent repitition of other useless cute consumes a total of some 60 pages, or more, and this without any advantage to the reader. Why publishers will persist in doing this sort of thing, or why writers will allow the use of such cuts in their books, is quite beyond comprehension.

PHILIP MILLS JONES, M. D.

Cards are out announcing the marriage of Miss Lucy A. Henning, daughter of Mrs. M. Henning, to Mr. E. M. Van Frank, at the Second Unitarian Church, San Francisco, on Tuesday, June 7th, and the host of electrical friends who attend the ceremony attest the high esteem in which the groom is held in the hearts of those of his chosen profession. Mr. Van Frank, as is well known, is general superintendent of the Sutro railroad and the most cordial congratulations of all are extended to him and his estimable bride.

Electro-Therapeuty

ON THE USE OF ELECTRIC CURRENT FROM CENTRAL STATIONS.

By PHILIP MILLS JONES, M. D.

DR. M. Hertzstein, of San Francisco, recently demonstrated the clinical aspect of a device for utilizing the 115-volt incandescent electric lighting current for certain medical purposes; the demonstration was principally along one line of work only, being the Doctor's improved method of examining the rectum and lower intestinal canal, but the principle of the apparatus has a very wide application in medicine. From the one piece of apparatus it is possible to obtain the appropriate currents of any and all uses which the medical man has for electricity, excepting of course the high tension currents derived from theinfluence or static machine.

The particular apparatus demonstrated by Dr. Hertzstein was made by Hirschman of Berlin, but the principle of the apparatus was developed and perfected, quite independantly, in this country by the writer.

It depends essentially upon what is known in electrical work as the "shunt circuit" the shunt being the fundamental principle of the entire device. A shunt circuit is a circuit formed by connecting two points of a closed circuit that are at different potentials together, thus forming a secondary path through which a portion of the current may pass; the voltage of the current passing in the shunt circuit will depend upon the voltage represented by the difference of potential between the two points of the principle circuit which are thus connected. Of course the maximum current obtainable in the shunt circuit will be determined by the resistance of the two circuits, and the maximum voltage, or difference of potential in the shunt circuit will be the voltage of the circuit from which the shunt is derived. If we connect the ends of a long straight wire to the terminals of the 115-volt lighting circuit, having such a resistance that about two amperes will pass, and then connect the leads from a voltmeter to two points on this wire, we will find that the voltage of the current passing through the voltmeter will depend entirely upon the distance between the voltmeter leads and that the current passing in the shunt circuit will have a direct relation to its voltage and the relative resistance of the two circuits.

Such being the principle of the apparatus, it is only necessary to know the various voltages and current strengths required in medical work in order to calculate the sizes of wire, proportions of the shunt circuits, points of attachment, etc. This the writer has been working upon for the last three years, a brief statement relative to it having been made to the San Francisco County Medical Society about a year ago.

The principle uses which the medical man has for electricity are as follows: For general treatment by the constant direct current employing up to 75 volts with a

current strength of from one to two hundred milliamperes; for exciting the primary circuit of an induction coil for the purpose of obtaining the induced, or so-called "faradic" currents; for supplying current to small incandescent lamps for illuminating the cavities of the body that are not readily accessible; for heating electro-cautery knives; and for running small motors.

All of these various purposes may be subserved by the one piece of apparatus and with perfect safety and satisfaction, either singly or all at the same time; and further more the apparatus is permanent.

It is better to make the apparatus with two main circuits, one for the supply of current for the small lamps, faradic coil and general treatments, and the other for the electro-cautery. In this way a very considerable saving of current is obtained over the method of using but one main circuit from which all the various shunts are derived. The main circuit for the small lights, etc., is calculated to suit the nature of the work to be done, being as a general rule made of about eight hundred feet of German-silver wire, number 18, B. & S. gauge. The connections for the shunts are also calculated to suit the needs of the user and may be arranged to give any voltage from a fraction of a volt up to the maximum, 115 volts. The current strength in the main circuit just mentioned is about two amperes, the current required for two 32 c. p. lamps; this may be increased or lessened if desired or required.

The other main circuit is different in design and construction, owing to the fact that currents of very considerable strength are needed in this work of electro cauterization. The connections too are not the same for the reason that if a high voltage current is used in the strengths required to heat some of the knives employed by surgeons, an undesirable arcing occurs at the contact switch in the cautery knife handle. There are no fixed points from which the shunt currents are derived, but instead the main connection is switched to different points along the resistance wire of the main circuit, thus cutting out some of the resistance in the main circuit as the need for more current in the cautery knife arises. This is essentially the principle of the apparatus demonstrated by Dr. Hertzstein, with the exception that on his apparatus there is no connection for the so-called "galvanic" current treatment nor has the instrument any induction coil attached, the doctor preferring to have these on a separate apparatus.

It is almost obvious that any or all of these various currents may be used at the same time, if so desired, simply by making the proper connections and shunts; very often it is quite handy to have the means for illumination and cauterization available at the same time and without the necessity of making any changes in the connections or arrangement of the apparatus or wires. The current for a motor may be obtained from any of the connections by the simple use of a switch, or a separate connection may be placed on the switch-board at the time of construction.

The question of safety has arisen at various times and the writer has been frequently asked if this form of apparatus was perfectly safe and free from even the possibility of injury to the patient. There is really no danger in the use of the apparatus if the current supply is from the underground mains of the lighting circuit; if the current is furnished by over-head wires and there are any arc circuit wires on the same poles, it would hardly be safe to use this apparatus, but as almost all the wires are now underground the question of danger is practically nil. The device, as will be seen at a glance, admits of adaption to almost any form of a table, and the cost may be also a very variable item. If one desires to have marble and solid brass, together with the standard instruments for current measurements, he will have to pay for these things; if plain hard wood and no instruments will suffice, the total cost will of course be much less. Several forms of the apparatus have been made.

ON THE ORIGIN OF THE AURORA

By W. STUART-SMITH.

MR. Alexander McAdie, in the October "Century", writes entertainingly of the aurora, that dancing light of the polar skies which, since the mind of man first reached the stage of development which enabled him to formulate "why," has been a source of constant wonderment. One can well understand the awe with which the untutored mind of the savage would regard this light, which, without apparent cause, springs from the depths of night, and shoots its arrows into the darkness, silent, mysterious, well calculated to excite those feelings of superstition with which primitive man regarded all which his want of knowledge did not enable him to understand.

In discussing the origin of the aurora. Mr. McAdie cites the explanations offered independently by Bigelow and Paulson, namely, that the light is caused, in the upper regions of the atmosphere, by some transformation of ether vibrations which results in the production of luminous rays. In another part of his article he gives quotations to show that the light is sometimes very close to earth, in one instance instrumental measurement having located it at less than two-fifths of a mile above the surface; and the writings of General Greeley show that at the high latitude in which he made his observations it was almost within reach of a man standing on the ground. These facts indicate that the manifestations are not confined to the upper regions of the atmosphere, and that an attenuated condition of the atmosphere is not essential for their production. It is also stated that it is known that while they are from fifty to seventy miles high in latitude 50 deg., the height decreases as 68 deg. is approached—that is, as a higher latitude is attained.

It would seem that this statement is too broadly made, as it is based on a very limited number of observations. A glance at the polar projections of the heavens given in

the "Century" article will show that the center from which the manifestations emanate is not located at the geographical pole, but is some distance south, and, while sufficient data is not given definitely to locate this region, there is little doubt that it is the upper Hudson Bay or approximate magnetic North Polar region. As this is far to the south of the geographical pole on the western shores of the Atlantic, it would seem that in naming the latitude at which the height of the aurora is observed, it is of the highest importance to give the longitude also. It is very probable that in the eastern part of North America and western part of Europe the aurora will be at a much lower altitude than in Western America or Eastern Asia; also that it will be seen much farther south. Indeed, that this is true the writer can confidently assert as he passed many hours, when a boy, watching the aurora as it appeared from his home in central New York, where the display was of frequent occurrence and often of great brilliancy, covering the entire northern heavens for many degrees above the horizon and sending steamers far toward the zenith. Since then he has passed many years on the shores of the Pacific, in approximately the the same latitude, both in America and Asia, and has never once seen any indication of the aurora. Also, it was his fortune to spend some weeks in November and December, 1882, and January, 1883, in Southern Patagonia, and saw no aurora, though those were years when it might have been expected. It will be noted that this region lies about the same with respect to the south magnetic polar region as North Pacific does to the magnetic pole of the North.

An assertion which can be made with the greatest confidence is that these luminous manifestations are sometimes seen close to the earth in places far removed from the magnetic polar regions. One evening during the last week in August, 1883, the writer was in Richfield Springs, New York, and saw bands of light slowly drifting across the main street of the village, but a few feet above the street. The length of street occupied was, perhaps, three or four hundred feet, the light in some places appearing as a sheet a few inches thick and in other places consisting of several layers with dark spaces between, the height of the whole being, perhaps, ten feet. The drift was through the trees on one side of the street, the tops of the trees being far above the light, thus clearly fixing the height. Later in the evening he was driving along a road about two miles out of the village and saw another similar display. The carriage was stopped and some time spent in watching the light slowly drifting directly overhead and certainly not more than twenty feet above the ground. There is absolutely no question about this being mist illuminated by stars or moon. It certainly was not this, but was unquestionably a self--luminous something slowly drifting in the atmosphere. The night was cool, clear and highly invigorating and where was some auroral display in the north. The light in question was, however, purely local in its character and was in small patches miles apart. It was in no manner connected with the auroral display of the northern sky though undoubtedly due to the same cause.

The "Century" article says that feeble displays are sometimes seen in the southern part of United States, but only at times of violent thunderstorm activity. If lights are seen when it is raining or the wind is blowing hard they may be caused by a brush discharge between clouds similar to the lights sometimes seen on board ship and known as St. Elmo's, but if there is violent lightning discharge between clouds while the atmosphere is quiescent the lights may be true aurora, as will be seen later. As far as the observations of the writer go, violent atmospheric disturbances of any kind are adverse to auroral displays, and probably rain or high wind at the point of origin would be fatal to them. Atmospheric quiescence seems not to be the only essential, as when auroral displays are seen the atmosphere is generally clear, cool and very invigorating. Feeble displays may some times be seen in a sultry atmosphere in case of violent lightning discharge, as noted above, though in such cases a sultry atmosphere is quickly cleared from causes to be mentioned later.

Looking again at the "Century" map of the heavens it will be seen that the light streams, starting from the magnetic polar regions, lie along the lines of force of the earth's magnetism. Observation shows that generally in the neighborhood of the magnetic pole they come close to the earth and are far removed from the surface in places comparatively remote from the polar regions. Is it not possible that consideration of these facts may throw some light on this wonderful phenomenon? There is a polar region where the magnetism is most intense; in this intense field and near where the lines of force enter the earth the intensity of illumination is greatest and frequently very near the surface. The greatest auroral displays occur at times of greatest sun disturbance as indicated by sun spots, also at these times there are heavy electric discharges and earth currents and greatest intensity of earth's magnetism, the variations becoming so great at times as to appropriately be termed electric and magnetic storms. The connection between the auroral displays and the electric and magnetic disturbances is certain; the manner of the connection unknown.

It has been suggested that certain motions of the ether are altered just enough to cause them to become luminous; but, as far as the writer knows, no explanation has been offered as to why such alteration causes the manifestations to lie along the lines of force of the earth's magnetism, or why they are most intense in those places where the magnetic field is strongest. It has, it is true, been suggested that the directive influence may be due to heavy currents of electricity passing through the atmosphere, but the atmosphere is not generally considered to be a good conductor, especially in the more dense portions near the surface, where the aurora is sometimes very brilliant. Perhaps no other explanation will be given, but an attempted explanation would certainly give due regard to all the elements of the atmosphere with

view to determining whether any can in any manner be influenced by the earth's magnetism and, if so, whether such element or elements can be caused to exist in any peculiar state.

Examination of the atmosphere reveals the presence of oxygen in large quantities, and experiment shows this element to possess magnetic qualities in a high degree, and that it is, therefore, susceptible to the directive infuence of the earth's magnetism. Examination shows no other considerable ingredient of the atmosphere which possesses the magnetic quality to any marked extent.

There is no reason for supposing that oxygen, in its normal state, can have its vibration period altered so as to become self-luminous except by increase of temperature, but further experiment shows that this element possesses the property of existing in a certain unstable state called ozone, and that in this state it possesses the properties which are foreign to it when in its normal condition. Also the peculiar molecular condition of oxygen in this state is brought into existence by electric discharge or by a dielectric strain which may or may not be followed by an electric discharge. Thus there is found in the atmosphere a substance which is susceptible to the directive influence of the earth's magnetism and which can be thrown into a peculiar molecular state in times of violent electric disturbance. In a quiescent atmosphere, oxygen in this state of molecular strain may float for some time, as would a body of vapor, and dispersion would be especially slow in a strong magnetic field capable of so directing the molecules as to make their mutual attractions add to the stability of the mass in virtue of the magnetic quality possessed by ozone.

Ozone as produced gives off no light that is manifest. Neither would a great mass of extremely small magnets show any sign of external magnetism if they were thoroughly jumbled together, but if the individual small magnets were free to turn on transverse axes and the whole were placed within a strong magnetic field they would be so directed as to form a large magnet with strong external field. Just so it may be that when all the molecules of a mass of ozone are directed by the influence of a magnetic field so as to assist one another instead of interfering, the mass will become self-luminous. Dispersion of the mass by rain or wind would cause the light to disappear. Such a directed mass of ozone might cause the local drifting lights seen by the writer, and in case of violent lightning discharge between clouds in a quiescent atmosphere the production of ozone might be followed by a faint luminosity after the molecules of the produced ozone had become directed by the earth's magnetism. This would explain the faint auroral displays mentioned by Mr. McAdie as sometimes accompanying violent thunder storms. In this connection it is to be especially noted that in clear, cool, invigorating weather, such as is common during auroral displays, the air is highly ozonized and the clearing of the atmosphere by thunder-storms is the result of the ozone produced.

Again, since the atmosphere consists to a large degree of oxygen—a magnetic substance, and since a magnetic substance tends to travel along magnetic lines of force toward those places where the intensity of the field is greatest, it may be expected that in the magnetic polar regions the percentage of oxygen in the air will be much greater than in places of weaker magnetic force far removed from the poles. Indeed, but for winds, probably magnetic action would cause the oxygen practically to displace all the other constituents of the atmosphere in the strong magnetic region near the poles, the atmosphere in those regions becoming nearly all oxygen.

Owing to the probably greater amount of oxygen in the atmosphere of the magnetic polar regions, the production of ozone will be greater there than elsewhere; that which is produced in the neighborhood of the polar regions will tend to move toward the accumulate there; the tendency to dispersion will be less than in other places, owing to the magnetic action, giving stability to the mass. Owing to all these causes the accumulation of ozone in these regions may become very great, especially in the higher altitudes out of reach of the more violent atmospheric disturbances. It would, of course, be greatest in times of great electric disturbance and great magnetic intensity, as these would be times of greatest production and maximum stability.

If aurora has its origin in masses of ozone, the swaying, folding and curving of the light may be caused by the movements given to the masses by air currents, and the shooting rays and sudden appearing and disappearing of the manifestations may be due to dispersion of the masses by gusts of wind followed by immediate redirecting by the magnetic force after the gust has passed. The colors seen may be due to light interference during the movements and partial disarranging of the mass.

Such spectrum data as the writer has been able to find shows evidence of the vapors of a number of substances, alway in a state of extreme tenuity. This is but what might be expected in the case of most substances, since they only exist in the atmosphere in very small quantities; but this might not be expected in the case of nitrogen, which constitutes so large a part of the atmosphere. Even this, however, is subject to a possible explanation. When the molecules of the ozone are magnetically directed, their mutual attractions are greatly increased owing to their inherent magnetic quality, and they will come together so as to increase the density of the mass. This movement will result in the displacement of non-magnetic substances to a very great extent, so that even close to the earth's surface nitrogen will exist in the mass only in a state of tenuity, and the spectroscope will so show it.

Mr. McAdie says there is one bright line which is always present in the spectrum of the aurora; the writer has not been able to find data showing the location of this line, nor has he been able to discover whether ozone shows any spectrum peculiarities not possessed by oxy-

gen in its normal state. Probably it does. The matter is one easily determined by those having facilities for making the experiment.

The evidence in favor of the aurora having its origin in ozone may be summarized as follows:

We have as a considerable ingredient of the atmosphere a magnetic substance which probably exists in greater quantities in the magnetic polar regions than elsewhere, especially in calm weather; we find that this magnetic substance is capable of existing in a state of molecular strain when it possesses properties very different from those common to it in its normal condition; we find that this peculiar state of strain is produced whenever there is an electric discharge in the magnetic substance, or when there is a state of intense dielectric strain which may or may not result in electric discharge; we find that when a mass of this magnetic substance in this strained state has its molecules directed by a magnetic field, the mutual attraction of the molecules of the mass should cause it to have a certain amount of stability which will prevent easy dispersion; sometimes during thunderstorms when violent electric discharges are certain to result in the production of the molecular strain in considerable masses of the magnetic substance, feeble and sporadic displays of aurora are seen; we find that at certain regular periods great disturbances occur in the sun, and that these disturbances are accompanied by violent electric and magnetic changes on the earth, and that electric discharges take place or dielectric strains are set up such as may result in the strained condition of large masses of the magnetic ingredient of the atmosphere; we find a probability of there always being a considerable amount of the strained magnetic material in the polar regions, especially in the upper regions of the atmosphere, away from the dispersive influence of the wind; also there is every probability that the amount of strained material in the polar regions is very great during periods of great sun disturbance, both because the production is greater during those periods than at other times, and because there will be a great tendency to accumulate owing to the magnetic field being more intense during those periods than at other times; finally, there is generally some aurora to be seen in the polar skies, the brilliancy becoming a maximum during periods of great sun disturbance. There must be some fire beneath all this smoke.

ELECTRICAL ENTERPRISE IN WESTERN TOWNS.

The far western parts of the United States—that is, the part west of the Missouri river—is a country full of enterprise. Fancy a Russian, or even a German or British town of 1500 inhabitants, ordering an electric light plant which would have to be hauled over mountainous bridle paths for 150 miles from the nearest railway station before it reached its destination! Yet this is what the town of Lander, in Wyoming, had the courage to do, each mule employed taking twelve days to make the round trip between Bitter Creek, on the Union Pacific Railway, and the town whose progress was apparently impeded for want of the latest and most expensive means of artificial illumination. The town of Sheridan, also in Wyoming, had only 600 inhabitants and was 200 miles from the nearest railroad when it discovered that an electric light plant was essential to a continuance of its self-respect. Accordingly the plant, packed in very small pieces, was hauled 200 miles, and Sheridan was happy. Since then this town has had a stroke of luck, for the Burlington Railway, pushing its way toward the Yellowstone River, has gone rght through it, thereby increasing its population at a single bound from 600 to 1000. Buffalo, another town in the same State, having 600 inhabitants, thought 44 miles a comparatively short distance to haul its electric light plant.

In the adjoining State of Idaho, the important town of Lewiston, with 2000 inhabitants, had its electric light plant hauled on boats for 80 miles up the Snake River. Murray, with 700 inhabitants, had a 60-mile overland passage to accomplish, or about the same length that Silver City, with a hundred less population, hauled its electric light plant. Turning now to places situated on the railways it is found that Newcastle, Cambria, Rawlins, Rock Spring, Green River, and Evanston, in Wyoming, and Pocatello and Idaho Falls, in Idaho, have each an electric light plant, though the population of not a single one of these towns exceeds 300. Boise City, Idaho, as befits a town puffed up with 8000 inhabitants, has not only an electric light plant, but a system of trolley cars.

Moreover, as some natural hot springs happen to be close to Boise City, the citizens heat their houses with the hot water from them, and even raise early spring vegetables by using the hot springs for irrigation purposes. The three small mining camps of Coeur D'Alene, Wallace and Wardner use electricity for lighting purposes all the year around, while their available water supply is used to run the mills for stamping ore. But in winter when the main water supply is frozen, the electric current is connected with the stamping mills, and lighting and power is furnished by a lavish expenditure on coal at $10 a ton.—Cassier's Magazine.

WATER POWERS OF ELDORADO COUNTY.

The question of power is always one of pressing importance to a mining section. In this respect El Dorado county is well provided for, as in a number of places water is available as a source of power, and in a greater portion of the county wood is still cheap and plentiful enough to render steam an economical power, but in view of the advances which have been made in the application of electricity as a motive power, especially in mining, it is evident that it is the coming power in El Dorado county, as well as elsewhere. Such being the case, El dorado county has the solution of the power question

within its borders, as its streams are capable of developing sufficient power to run the State.

No portion of California has a finer water supply than El Dorado county. The Middle and South Forks of the American and the various forks of the Consumnes, together with their tributaries and mountain lakes, the majority of which are situated favorably for storage purposes, form an unsurpassed water system, one capable of supplying not only the needs of the county, but those of Sacramento, Contra Costa, and Alameda counties. The topography of the country is such that water can be carried by ditches to all but a small part of it.—Placerville Democrat.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

THE "ELECTRA" CARBONS.

Mr. Hugo Reisinger, No. 38 Beaver Street, New York, sole agent for the celebrated "Electra" Highest Grade Nuernberg Carbons, desires the publication of the following notice in refutation of statements recently made in trade papers:

"I wish to inform the trade that the word 'Electra' has been properly registered by me as my trade mark and therefore, can not be used by anybody else without infringing on my rights. The 'Electra' carbons are made, as heretofore, by the world renowned firm of C. Conradty, Nuernberg, who owns not only the oldest, but the most extensive carbon works in existence and whose carbons remain unequalled in quality and efficiency, having become the standard for electric lighting the world over. As to parties reported as makers of 'Electra' carbons, I wish to state that I have brought suit against them for having misused the trade mark, 'Electra,' and that they have been enjoined by the Nuernberg courts from making any carbons stamped 'Electra,' under penalty of 100 Mks. for each carbon. I shall guard the interest of buyers of my carbons as heretofore, and any information in regard to infringements on the registered trade mark, 'Electra,' that will enable me to take legal proceedings, will oblige."

The following self-explanatory letter from Mr. Reisinger's attorneys is also given, and will be read with interest by all users of carbons for constant potential arc lamps, and particularly by those who prefer the use of the genuine "Electra" carbons to all others. The letter referred to is as follows:

New York, January 4th, 1898.

Messrs. Schiff, Jordan & Co., 232 Greenwich St., City.

Dear Sirs—Mr. Hugo Reisinger, of this city, who has the sole right of dealing in the carbons known as "Electra" carbons, has shown us your advertisement in the "Electrical World," in the number of January 1st, and on page xi, in which you refer to Julius Fuchs at the manufacturer of the "Electra" carbons, and you state that that product will, in future, bear only your trade mark, "Schiff Carbons." We have advised Mr. Reisinger that such use of the trade name "Electra" is illegal, and in violation of his sole and exclusive right to the use of that trade name in connection with carbons. On further reflection you will probably see that any illegal use of that word, in the past, by Julius Fuchs for the purpose of securing a trade and popularity for the carbons of his manufacture, when sold under that name, can not be transferred to the same carbons by notifying the public that the same carbons, formerly sold, will be sold under the new name. You must start with your new name, without reference to the name "Electra," which you have no right to use, and the prohibition in respect of which upon Mr. Fuchs, Mr. Reisinger is informed that you have been and are fully aware. Under these circumstances, Mr. Reisinger desires to notify you that you must at once desist from all use of the word "Electra" in connection with carbons, no matter what form it may be. The advertisement referred to above must be at once cancelled and withdrawn and all other advertisements in which such reference and use of the word "Electra" is made. We shall be glad to receive a letter from you promptly, giving us assurance that Mr. Reisinger's reasonable desires above expressed will be complied with.

.....

(Signed) WETMORE & JENNER.

EVIDENCES OF STURDY GROWTH.

The General Electric Company in view of the constantly growing demand for apparatus of its manufacturing, has decided to make a large increasein its manufacturing facilities. March 25th, the Company played contracts for the construction at its Schenectady Works, of a new foundry which will be one of the largest in this country. The present foundry has been for some time entirely inadequate to meet the demands upon it, and considerable work has been passed on to the admirably equipped foundry which the Company has at Lynn and Schenectady foundries, working orevtime and all is now to be concentrated in the new foundry, construction of which is to be begun immediately.

.. ..

The building will be of brick, 500 ft. long and 140 ft, wide with an "L" 100 ft. by 120 ft The latter will be used as a cleaning shop. Besides these main buildings a number of sand sheds, several smaller buildings for the storage of foundry material, and a new pattern store house 200 ft. long, 60 ft. wide and two stories high, will also be erected. All combined, the floor space occupied will be about 12,000 sq. ft. Plans are also under consideration for a new machine shop, 650 ft. long by 165 ft. wide, but the appropriation for this has not yet been authorized.

The building will be erected on the recently purchased property lying to the West of the present works and parallel with the Erie canal. The foundry will be built several hundred feet from the canal and will have in close proximity the sand sheds and pattern store houses. Every precaution will be taken to eliminate risk from fire; indeed the pattern storehouse will be made as absolutely fire proof as possible. The foundry, as laid out, will be a model of the most approved modern practice. Careful thought and study have been given to the matter, and the Engineers of the Company have drawn on the experience of other Companies which have recently constructed foundries. The building will be of imposing proportions, and will be in plain view from the New York Central tracks.

The contemplated machine shop will be built on the Central Avenue opposite building No. 15, and will be devoted almost entirely to very large machine work. The size of the great generators which the General Electric Company has been manufacturing, has of late been increasing until, to-day, a generator of 4000 h. p. is not now regarded as of unusual size. In fact, generators of 5000 h. p. are now in course of design, and the demand upon the shop in which the large machinery has heretofor been built has far outgrown its present proportions.

The middle aisle of the new machine shop will be 65 ft. wide, with narrower aisles down each side. Electric travelling cranes will be installed to operate along each aisle and a gallery will be built along one side only. All the large machine tools will be removed from their present locations to the new shop, their places being taken by smaller apparatus. The total floor space of this building will amount to not less than 144,250 sq. ft.